IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of :

Günter BAUR ET AL. : Group Art Unit: 2871

Serial No.: 08/627,386 : Examiner: PARKER, K

Filed: April 4, 1996 :

For: ELECTROOPTICAL LIQUID CRYSTAL SWITCHING ELEMENT

H30/Appeal Brief

BRIEF ON APPEAL

I hereby certify that this correspondence is being deposited with the U.S. Postal Services as First Class Mail in an envelope addressed To: Commissioner of Patents and Trademarks, Washington, D.C. 20231 On: 2/21/02
Name: CINDY HENTER
Signature:
Date: 2/21/02

Honorable Commissioner of Patents
Washington, D.C. 20231

Sir:

Further to the Notice of Appeal filed on November 21, 2001, herewith are three copies of Appellants' Brief on Appeal. The attached checks include the statutory fee of $320.00 for the filing of this Brief and the $110.00 for the extension fee.

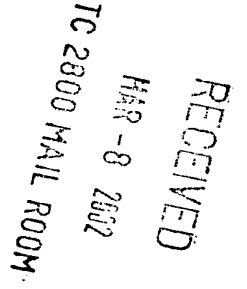
This is an appeal from the decision of the Examiner to maintain a rejection of all the claims as unpatentable under the judicially created doctrine of obviousness-type double patenting after a Terminal Disclaimer was filed over a patent over which the terms of the patents in issue have already been disclaimed and for rejecting claims 86 and 87 as indefinite.

(1) REAL PARTY IN INTEREST

The real party in interest in the present application is Merck Patent GmbH, to whom the parent application and all patents issuing therefrom were assigned to on February 6, 1996. The assignment was recorded on March 1, 1996. The parent application is now issued US Patent No. 5,576,867.

(2) RELATED APPEALS AND INTERFERENCES

There are no known related appeals or interferences.



(3) STATUS OF THE CLAIMS

Claims 20-35, 37-85 and 88-124 are pending in the application.

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MERCK-1753-D1

(4) STATUS OF AMENDMENTS AFTER FINAL

Not applicable - no amendments filed after final other than the attached amendment canceling claims 86 and 87 which are not being appealed at this time.

(5) SUMMARY OF THE INVENTION

Appellants' invention is directed to an Electrooptical Liquid Switching Element based on certain novel orientation features. The switching element has a liquid crystal layer and a reorientation means for reorienting the liquid crystal layer into a current orientation in which the electrooptical switching element has a different light transmission. See specification on page 1, lines 3-7.

(6) ISSUES

The issue outstanding in this application is:

Whether a Terminal Disclaimer filed over a patent over which the terms of patents have already been disclaimed, wherein said patents are the basis of a rejection based on the judicially created doctrine of obviousness-type double patenting, is sufficient to overcome the rejection?

(7) GROUPING OF THE CLAIMS

For the purpose of this appeal, all claims are considered to stand or fall together.

(8) APPELLANTS' ARGUMENTS

All claims were rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over all claims of U.S. Patent Number 5,841,498 and over U.S. Patent Number 5,841,499. See Office Action dated May 22, 2001.

The examiner raised double patenting issues with respect to USP 5,841,499 and USP 5,841,498 in the Office Action dated December 19, 2001. Any such rejections have already been rendered moot by the Terminal Disclaimer filed on June 4, 1999. Said Terminal Disclaimer referred explicitly to both U.S. patents.

It is true that the Terminal Disclaimer literally disclaims the term of a patent granted on this application which might extend beyond that of prior Patent 5,576,867. However, as can be seen in the Appendix by the accompanying copies of the front pages of U.S. Patents 5,576,867,

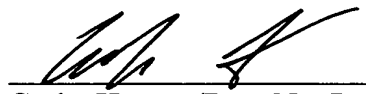
5,841,498, and 5,841,499, the terms of the latter two patents themselves have already been disclaimed with respect to the term of the '867 patent. Consequently, the term of all three already existing patents will be the same as that of '867 and the term of any patent issuing from this application will also be the same as that of '867. All requirements of a satisfactory terminal disclaimer are met.

Reversal of the rejection is therefore respectfully requested.

Conclusion:

All requirements of a satisfactory terminal disclaimer are met. Reversal of the rejection is therefore courteously requested.

Respectfully submitted,



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Attorney Docket No.: MERCK-1753-D1

Date: February 21, 2002

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APPENDIX

The claims:

20. An electro-optical display device comprising a plurality of liquid crystal switching elements which comprise a liquid crystal layer comprising liquid crystal molecules and having a surface for display of an image which is switched under control of an electric field having a component predominantly parallel to said surface, wherein said liquid crystal molecules have a pretilt angle α_o, $0° \leq \alpha_o < 30°$, and an orientation angle β_o, $0° < \beta_o < 90°$.

21. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o, $0° \leq \alpha_o \leq 25°$.

22. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o, $0° \leq \alpha_o \leq 20°$.

23. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o, $0° \leq \alpha_o \leq 10°$.

24. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o, $0° \leq \alpha_o \leq 5°$.

25. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o, $0° \leq \alpha_o \leq 3°$.

26. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o, $0° \leq \alpha_o \leq 2°$.

27. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o, $0° \leq \alpha_o \leq 1°$.

28. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o, $0° < \alpha_o \leq 20°$.

29. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o, $0° < \alpha_o \leq 10°$.

30. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o, $0° < \alpha_o \leq 5°$.

31. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o, $0° < \alpha_o \leq 2°$.

32. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o, $0° < \alpha_o \leq 1°$.

33. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o which is about 5°.

34. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o which is about 1°.

35. The electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein said liquid crystal molecules have a pretilt angle α_o which is about 0°.

37. An electro-optical display device of claim 20, wherein β_o is not 45°.

38. An electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein the liquid crystal layer has an untwisted structure in its initial orientation and can be reoriented to a twisted structure by said field component oriented predominantly parallel to the liquid crystal layer.

39. An electro-optical display device of claim 20, 37, 44, 63, 97, 99, 101, 102, 103 or 119, wherein the liquid crystal layer has a twisted structure in its initial orientation which can be untwisted by the field component aligned predominantly parallel to the liquid crystal layer.

40. The electro-optical display device of claim 20, wherein said liquid crystal switching elements further comprise:

(a) said liquid crystal molecules which are twistable;

(b) a substrate; and

(c) an electrode structure which generates said electric field having a component predominantly parallel to the surface of said liquid crystal layer.

41. The electro-optical display device of claim 40, 44 or 119, wherein the initial twist angle ß of the liquid crystal molecules is within 15 degrees of 0°, or within 15 degrees of 90°.

42. The electro-optical display device of claim 40, further comprising:

(d) a polarizer in optical relation with said liquid crystal layer; and

(e) a voltage source or a current source connected to said electrode structure.

43. The electro-optical display device of claim 40, further comprising:

(d) a polarizer in optical relation with said liquid crystal layer; and

(e) a voltage source connected to said electrode structure.

44. An electro-optical display device comprising a plurality of liquid crystal switching elements which comprise a liquid crystal layer comprising liquid crystal molecules and having a surface for display of an image which is switched under control of an electric field having a component predominantly parallel to said surface, wherein said liquid crystal molecules have a pretilt angle α_o, $0° \leq \alpha_o < 30°$,

wherein said liquid crystal switching elements further comprise:

(a) said liquid crystal molecules which are twistable;

(b) a substrate;

(c) an electrode structure which generates said electric field having a component predominantly parallel to the surface of said liquid crystal layer;

(d) a polarizer in optical relation with said liquid crystal layer;

(e) a voltage source connected to said electrode structure; and

(f) an orientation layer, in contact with at least one surface of said liquid crystal layer, which aligns the liquid crystal molecules in a direction whereby they have an orientation angle $ß_o$, $0° < ß_o < 90°$.

45. The electro-optical display device of claim 44 or 119, comprising an orientation layer, in contact with at least one surface of said liquid crystal layer, which aligns the liquid crystal molecules in a direction whereby they have said pretilt angle α_o, $0° \leq \alpha_o < 30°$.

46. The electro-optical display device of claim 20, wherein said liquid crystal layer is nematic.

47. The electro-optical display device of claim 42, further comprising an analyzer in optical relation with said polarizer.

48. The electro-optical display device of claim 20, wherein $\Delta n \cdot d/\lambda$ of the liquid crystal layer is larger than zero but smaller than four.

49. The electro-optical display device of claim 40, wherein the axes of switching-effective twisting of the liquid crystal molecules are substantially perpendicular to the plane of the substrate.

50. The electro-optical display device of claim 40, wherein, within the image spot of the liquid crystal switching element, said electrode structure is formed between the substrate and the liquid crystal layer and has at least one pair of electrodes with a space therebetween.

51. The electro-optical display device of claim 50, wherein each pair of electrodes comprises strip- or line-type electrodes which extend to make a space between said pair of electrodes.

52. The electro-optical display device of claim 51, wherein the electrodes intermesh in comb fashion.

53. The electro-optical display device of claim 50, wherein the space between the pair of electrodes is 2 μm to 50 μm.

54. The electro-optical display device of claim 50, wherein the applied voltage between the pair of electrodes is one volt to 80 volts.

55. The electro-optical display device of claim 40, wherein the thickness of the liquid crystal layer is 1 μm to 10 μm.

56. The electro-optical display device of claim 40, wherein the area of the image spots of the liquid crystal switching elements is 10 μm^2 to 1 mm^2.

57. The electro-optical display device of claim 40, wherein the plurality of liquid crystal switching elements are arranged in the form of a matrix.

58. The electro-optical display device of claim 57, wherein said matrix is an active matrix.

59. The electro-optical display device of claim 20, wherein the plurality of liquid crystal switching elements are addressed by the time multiplex method.

60. The electro-optical display device of claim 59, wherein the switching elements are used to alter the brightness and/or color of a pixel of the electro-optical display device.

61. The electro-optical display device of claim 58, wherein the active matrix is a transistor matrix.

62. The electro-optical display device of claim 40, wherein the electrode structure is located in one plane.

63. An electro-optical display device comprising a plurality of liquid crystal switching elements which comprise a liquid crystal layer comprising liquid crystal molecules and having a surface for display of an image which is switched under control of an electric field having a component predominantly parallel to said surface, wherein said liquid crystal molecules have a pretilt angle α_o, $0° \leq \alpha_o < 30°$,

wherein said liquid crystal switching elements further comprise:

(a) said liquid crystal molecules which are twistable;

(b) a substrate; and

(c) an electrode structure which generates said electric field having a component predominantly parallel to the surface of said liquid crystal layer,

wherein the electrode structure is arranged alternately in at least two different planes in parallel with the substrate.

64. The electro-optical display device of claim 63, wherein the electrode structure is located between a substrate and the liquid crystal layer.

65. The electro-optical display device of claim 64, wherein said at least two planes are located between the liquid-crystal layer and a substrate.

66. The electro-optical display device of claim 65, wherein said two planes of the alternating electrodes are formed by the two opposite surfaces of a thin layer.

67. The electro-optical display device of claim 66, wherein said thin layer is an insulating film.

68. The electro-optical display device of claim 40, wherein the liquid-crystal switching elements comprise a multiplicity of pixels.

69. The electro-optical display device of claim 47, wherein the angle between the direction of the initial orientation of the liquid crystal molecules at the surface of the liquid crystal layer on the side of the polarizer and the light transmitting direction of the polarizer is approximately 0°, and the angle between the light transmitting direction of said polarizer and the light transmitting direction of the analyzer is approximately 0° or approximately 90°.

70. The electro-optical display device of claim 47, wherein the angle between the direction of the initial orientation of the liquid crystal molecules at the surface of the liquid crystal layer on the side of the polarizer and the light transmitting direction of the polarizer is approximately 90°, and the angle between the light transmitting direction of said polarizer and the light transmitting direction of the analyzer is approximately 0° or approximately 90°.

71. The electro-optical display device of claim 20 further comprising a polarizer in optical relation with the liquid-crystal layer.

72. The electro-optical display device of claim 71, comprising an analyzer in optical relation with the liquid-crystal layer.

73. The electro-optical display device of claim 20, wherein the liquid crystal layer contains a dichroic dye.

74. The electro-optical display device of claim 20 further comprising a current or voltage source.

75. The electro-optical display device of claim 20 further comprising a voltage source.

76. The electro-optical display device of claim 20 which is driven by a matrix of active switching elements.

77. The electro-optical display device of claim 58, wherein the switching elements of the active matrix are thin-film transistors.

78. The electro-optical display device of claim 20, wherein the switching elements are provided with optical compensation.

79. The electro-optical display device of claim 20, wherein the switching elements comprise a birefringent optical compensator in optical correlation with the liquid-crystal layer.

80. The electro-optical display device of claim 20, wherein said liquid crystal layer comprises a polymer.

81. The electro-optical display device of claim 36, wherein β_o is not about 40° and not about 50°.

82. The electro-optical display device of claim 20 which is driven by a direct triggering device.

83. The electro-optical display device of claim 20 which is directly driven according to the time multiplex method.

84. An electro-optical display device comprising a liquid crystal layer comprising liquid crystal molecules and having a surface for display of an image which is switched under control of an electric field having a component predominantly parallel to said surface, wherein said liquid crystal molecules are in homogeneous alignment and have a pretilt angle α_o and an orientation angle β_o which prevent domain formation in said image and/or which impart to said image a small viewing angle dependence and a correspondingly improved image contrast.

85. An electro-optical display device comprising a liquid crystal layer comprising liquid crystal molecules and having a surface for display of an image which is switched under control of an electric field having a component predominantly parallel to said surface, wherein said liquid crystal molecules are in homogeneous alignment and have a pretilt angle α_o and an orientation angle β_o which reduce domain formation in said image and/or which impart to said image a small viewing angle dependence and a correspondingly improved image contrast.

88. An electro-optical display device of claim 85, wherein said α_o and β_o values impart to said image a small viewing angle dependence wherein the variation of the degree of light transmission (1-

fmin/fmax) is, over all φ values, below about 0.57 when $\ominus$ is up to 45°.

89. An electro-optical display device comprising a liquid crystal layer comprising liquid crystal molecules and having a surface for display of an image which is switched under control of an electric field having a component predominantly parallel to said surface, wherein said liquid crystal molecules are in homogeneous alignment and said device has an initial state configuration in the absence of electric field which during operation reduces domain formation in said image and/or which imparts to said image a small viewing angle dependence and a correspondingly improved image contrast.

90. A liquid crystal switching element comprising a liquid crystal layer comprising liquid crystal molecules and having a surface for display of an image which is switched under control of an electric field having a component predominantly parallel to said surface, wherein said liquid crystal molecules have a pretilt angle α_o, $0° \leq \alpha_o < 30°$, and an orientation angle $ß_o$, $0° < ß_o < 90°$.

97. An electro-optical device of claim 20, wherein said liquid crystal molecules have an orientation angle β_o which is not 40°, not 45° and not 50°.

98. An electro-optical device of claim 20, wherein said liquid crystal molecules have an orientation angle $\beta_o > 50°$ or $\beta_o < 40°$.

99. An electro-optical device of claim 20, wherein said liquid crystal molecules have an orientation angle $\beta_o > 55°$ or $\beta_o < 35°$.

100. An electro-optical device of claim 20, wherein said liquid crystal molecules have an orientation angle $\beta_o > 60°$ or $\beta_o < 30°$.

101. An electro-optical device of claim 20, wherein said liquid crystal molecules have an orientation angle $\beta_o > 65°$ or $\beta_o < 25°$.

102. An electro-optical device of claim 20, wherein said liquid crystal molecules have an orientation angle $\beta_o > 70°$ or $\beta_o < 20°$.

103. An electro-optical device of claim 20, wherein said liquid crystal molecules have an orientation angle $\beta_o > 75°$ or $\beta_o < 15°$.

104. An electro-optical device of claim 20, wherein said liquid crystal molecules have an orientation angle $\beta_o > 80°$ or $\beta_o < 10°$.

105. An electro-optical display device of claim 20, wherein the liquid crystal layer has an untwisted structure in its initial orientation and can be reoriented to a twisted structure by said field component oriented predominantly parallel to the liquid crystal layer.

106. An electro-optical display device of claim 22, wherein the liquid crystal layer has an untwisted structure in its initial orientation and can be reoriented to a twisted structure by said field component oriented predominantly parallel to the liquid crystal layer.

107. An electro-optical display device of claim 24, wherein the liquid crystal layer has an untwisted structure in its initial orientation and can be reoriented to a twisted structure by said field component oriented predominantly parallel to the liquid crystal layer.

108. An electro-optical display device of claim 27, wherein the liquid crystal layer has an untwisted structure in its initial orientation and can be reoriented to a twisted structure by said field component oriented predominantly parallel to the liquid crystal layer.

109. An electro-optical display device of claim 28, wherein the liquid crystal layer has an untwisted structure in its initial orientation and can be reoriented to a twisted structure by said field component oriented predominantly parallel to the liquid crystal layer.

110. An electro-optical display device of claim 30, wherein the liquid crystal layer has an untwisted structure in its initial orientation and can be reoriented to a twisted structure by said field component oriented predominantly parallel to the liquid crystal layer.

111. An electro-optical display device of claim 32, wherein the liquid crystal layer has an untwisted structure in its initial orientation and can be reoriented to a twisted structure by said field component oriented predominantly parallel to the liquid crystal layer.

112. An electro-optical display device of claim 20, wherein the liquid crystal layer has a twisted structure in its initial orientation which can be untwisted by the field component aligned predominantly parallel to the liquid crystal layer.

113. An electro-optical display device of claim 22, wherein the liquid crystal layer has a twisted structure in its initial orientation which can be untwisted by the field component aligned predominantly parallel to the liquid crystal layer.

114. An electro-optical display device of claim 24, wherein the liquid crystal layer has a twisted structure in its initial orientation which can be untwisted by the field component aligned predominantly parallel to the liquid crystal layer.

115. An electro-optical display device of claim 27, wherein the liquid crystal layer has a twisted structure in its initial orientation which can be untwisted by the field component aligned predominantly parallel to the liquid crystal layer.

116. An electro-optical display device of claim 28, wherein the liquid crystal layer has a twisted structure in its initial orientation which can be untwisted by the field component aligned predominantly parallel to the liquid crystal layer.

117. An electro-optical display device of claim 30, wherein the liquid crystal layer has a twisted structure in its initial orientation which can be untwisted by the field component aligned predominantly parallel to the liquid crystal layer.

118. An electro-optical display device of claim 32, wherein the liquid crystal layer has a twisted structure in its initial orientation which can be untwisted by the field component aligned predominantly parallel to the liquid crystal layer.

119. An electro-optical display device comprising a plurality of liquid crystal switching elements which comprise a liquid crystal layer comprising liquid crystal molecules and having a surface for display of an image which is switched under control of an electric field having a

component predominantly parallel to said surface, wherein said liquid crystal molecules have a pretilt angle α_o, $0° \leq \alpha_o < 30°$,

wherein said liquid crystal switching elements further comprise:

(a) said liquid crystal molecules which are twistable;

(b) a substrate;

(c) an electrode structure which generates said electric field having a component predominantly parallel to the surface of said liquid crystal layer;

(d) a polarizer in optical relation with said liquid crystal layer;

(e) a voltage source or a current source connected to said electrode structure; and

(f) an orientation layer, in contact with at least one surface of said liquid crystal layer, which aligns the liquid crystal molecules in a direction whereby they have an orientation angle ßo, $0° < ß_o < 90°$.

120. An electro-optical device of claim 44, 63 or 119, wherein said liquid crystal molecules have an orientation angle $\beta_o > 50°$ or $\beta_o < 40°$.

121. An electro-optical device of claim 44, 63 or 119, wherein said liquid crystal molecules have an orientation angle $\beta_o > 60°$ or $\beta_o < 30°$.

122. An electro-optical device of claim 44, 63 or 119, wherein said liquid crystal molecules have an orientation angle $\beta_o > 65°$ or $\beta_o < 25°$.

123. An electro-optical device of claim 44, 63 or 119, wherein said liquid crystal molecules have an orientation angle $\beta_o > 70°$ or $\beta_o < 20°$.

124. An electro-optical device of claim 44, 63 or 119, wherein said liquid crystal molecules have an orientation angle $\beta_o > 75°$ or $\beta_o < 15°$.

US005841499A

United States Patent [19]

Baur et al.

[11] **Patent Number: 5,841,499**

[45] **Date of Patent: *Nov. 24, 1998**

[54] **REFLECTION MODE LIQUID CRYSTAL DISPLAY DEVICES HAVING A PARALLEL ELECTRIC FIELD AND α_0 WHICH IS $\leqq$ 30°**

[75] Inventors: **Günter Baur**, Freiburg; **Waltraud Fehrenbach**, München; **Barbara W. Ne Staudacher**, Ettenheim; **Friedrich Windscheid**, Freiburg-Tiengen; **Rudolf Kiefer**, Vorstetten, all of Germany

[73] Assignee: **Merck Patent Gesellschaft Mit Beschrankter Haftung**, Darmstadt, Germany

[*] Notice: The term of this patent shall not extend beyond the expiration date of Pat. No. 5,576,867.

[21] Appl. No.: **627,388**

[22] Filed: **Apr. 4, 1996**

Related U.S. Application Data

[62] Division of Ser. No. 466,068, Jun. 6, 1995, Pat. No. 5,576, 867, which is a continuation of Ser. No. 363,968, Dec. 23, 1994, abandoned, which is a continuation of Ser. No. 877,187, Aug. 6, 1992, abandoned.

[30] **Foreign Application Priority Data**

Jan. 9, 1990 [DE] Germany 40 00 451.1

[51] **Int. Cl.**[6] **G02F 1/1343**; G02F 1/1337; G02F 1/141

[52] **U.S. Cl.** **349/141**; 349/33; 349/179; 349/136

[58] **Field of Search** 349/68, 67, 87, 349/123, 19, 138, 39, 42, 136, 141

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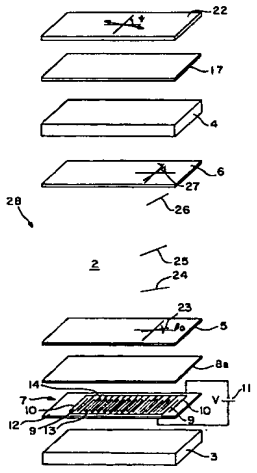
Primary Examiner—William L. Sikes
Assistant Examiner—Kenneth Parker
Attorney, Agent, or Firm—Millen, White, Zelano, & Branigan, P.C.

[57] **ABSTRACT**

An electro-optical display device comprising a liquid crystal layer achieves switching using an electric field component which is predominantly parallel to the surface of the liquid crystal layer. Low dependence of image contrast on viewing angle is achieved by selection of parameters including pretilt angle α_0, orientation angle β_0, etc. of the liquid crystal molecules in the layer. Reflection mode devices are described.

90 Claims, 8 Drawing Sheets



US005841498A

United States Patent [19]

Baur et al.

[11] Patent Number: 5,841,498

[45] Date of Patent: *Nov. 24, 1998

[54] **LIQUID CRYSTAL DISPLAY DEVICES HAVING A PARALLEL ELECTRIC FIELD AND β_O WHICH IS NOT 0 DEGREES OR 90 DEGREES**

[75] Inventors: **Günter Baur**, Freiburg; **Waltraud Fehrenbach**, München; **Barbara Weber Ne Staudacher**, Ettenheim; **Friedrich Windscheid**, Freiburg-Tiengen; **Rudolf Kiefer**, Vorstetten, all of Germany

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[52] **U.S. Cl.** **349/141**; 349/33; 349/136; 349/179

[58] **Field of Search** 359/68, 67, 87; 349/123, 19, 138, 39, 42, 136, 141, 33, 143, 179

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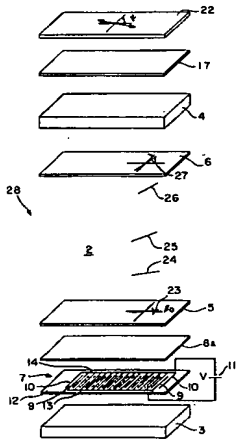
[57] **ABSTRACT**

An electro-optical display device comprising a liquid crystal layer achieves switching using an electric field component which is predominantly parallel to the surface of the liquid crystal layer. Low dependence of image contrast on viewing angle is achieved by selection of parameters including orientation angle β_o, and others, of the liquid crystal molecules in the layer.

102 Claims, 8 Drawing Sheets



US005576867A

United States Patent [19]

Baur et al.

[11] Patent Number: 5,576,867

[45] Date of Patent: Nov. 19, 1996

[54] **LIQUID CRYSTAL SWITCHING ELEMENTS HAVING A PARALLEL ELECTRIC FIELD AND β_O WHICH IS NOT 0° OR 90°**

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[21] Appl. No.: **466,068**

[22] Filed: **Jun. 6, 1995**

Related U.S. Application Data

[63] Continuation of Ser. No. 363,968, Dec. 23, 1994, abandoned, which is a continuation of Ser. No. 877,187, Aug. 6, 1992, abandoned.

[30] **Foreign Application Priority Data**

Jan. 9, 1990 [DE] Germany 40 00 451.1
Jan. 9, 1990 [WO] WIPO PCT/EP91/00022

[51] **Int. Cl.**[6] **G02F 1/1343**; G02F 1/1337; G02F 1/141

[52] **U.S. Cl.** **359/87**; 359/89; 359/78

[58] **Field of Search** 359/87, 89, 71, 359/73, 78

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[57] **ABSTRACT**

An electro-optical display device comprising a liquid crystal layer achieves switching using an electric field component which is predominantly parallel to the surface of the liquid crystal layer. Low dependence of image contrast on viewing angle is achieved by selection of parameters including orientation angle β_o and pretilt angle α_o of the liquid crystal molecules in the layer. For example, good results are achieved when $0°<\beta_o\leqq 20°$ for liquid crystal molecules having negative dielectric anisotropy and $70°\leqq\beta_o<90°$ for molecules having positive dielectric anisotropy. Preferably, $0°\leqq\alpha_o<30°$.

127 Claims, 8 Drawing Sheets